IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. of:	Robert J. SMALL and Zhefei J. CHEN	Confirmation No:	1702
Serial No:	10/057,206	Group:	1755
Filed:	January 25, 2002	Examiner:	M. Marcheschi
Entitled:	**Compositions for Chemical Mechanical Planarization of Noble-Metal-Featured Substrates, Associated Methods, and Substrates Produced by Such Methods**	Atty Docket:	63254-5002-US

DECLARATION OF ROBERT J. SMALL AND ZHEFEI J. CHEN UNDER 37 C.F.R. § 1.131

We, ROBERT J. SMALL and ZHEFEI J. CHEN declare as follows:

1. We are co-inventors named in the above-referenced patent application, which was filed on January 25, 2002 ("the Application").

2. We were employed by EKC Technology, Inc., located in Hayward, California and to whom we assigned the invention described in the Application. As part of our work for EKC, we developed and tested compositions for polishing a substrate having a noble metal material. The compositions comprised periodic acid or H_5IO_6, which was sometimes referred to as "PIA," and an abrasive. The compositions that we developed are the subject matter of the Application and all of our work regarding the development and testing of these compositions was done in the United States of America.

3. We understand that independent claims 77 and 112 in the Application stand rejected as being obvious over U.S. Patent No. 6,589,100 ("Moeggenborg 100") in view of U.S. Patent No. 6,461,227 ("Fang") and U.S. Patent Application Publication No. 2002/0076932 ("Dirksen"), alone or further in view of U.S. Patent Application Publication No. 2003/0139116 ("Moeggenborg 116"). We also understand that independent claim 94 also stands rejected based on Moeggenborg 100 in view of Fang and Dirksen, alone or further in view of Moeggenborg 116 and U.S. Patent Application Publication No. 2003/0119316 ("Klein).

4. We understand that the application that matured into Moeggenborg 100 was filed on September 24, 2001 and that this is considered the date of this reference for purposes of the rejection of indepentent claims 77, 94, and 112.

5. We declare that we conceived of and reduced to practice the inventions recited in independent claims 77, 94, and 112 prior to September 24, 2001 as discussed below.

6. Attached as Exhibit A hereto is a 47 page document entitled "Compositions for Nobel [sic] Metal Chemical-Mechanical Planarization Processes." This document has a date that is prior to September 24, 2001. This date has been redacted as evidenced by the redaction notice in the top right hand corner of Exhibit A.

7. Exhibit A describes several chemical-mechanical compositions that were made and several tests that were performed using such compositions prior to September 24, 2001. These compositions and tests illustrate the actual reduction to practice of the inventions as recited in independent claims 77, 94, and 112 in the Application. Exhibit A, pp. 3-7, 10-12, 18, 19, 23, 31, 35, and 36. These tests were performed in the context of developing chemical-mechanical polishing compositions for polishing substrates comprising noble metals. *Id.* at 1-2. Notably, the tests described in Exhibit A are also described in the currently pending Application. *See* U.S. Patent Application Publication No. 2003/0194879, paras. [0024], [0038], [0046], [0073], [0077], [0078], [0079], [0080]-[0082], [0124]-[0127],[0174], [0175], [0199], [0206], [0207], [0211], [218], and [219].

8. For example, independent claim 77 as currently pending reads as follows:

> 77. A combination of a chemical mechanical polishing composition in contact with a substrate surface having at least one feature thereon comprising a noble metal, said combination comprising:
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> a substrate comprising submicron integrated circuits and having a surface having at least one feature thereon comprising a noble metal;
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> said substrate surface contacting a chemical mechanical polishing composition comprising: periodic acid and an abrasvie in a combined

amount sufficient to render the substrate surface substantially planar and to maintain a polishing rate between 300 Angstroms per minute to about 2000 angstroms per minute upon chemical-mechanical polishing thereof, wherein periodic acid is in an amount from about 0.05 to about 0.3 moles/kilogram.

Exhibit A describes polishing iridium (Ir), which is a noble metal, with a polishing slurry (Composition A) having 2% by weight of alumina abrasive and 0.1 mol/kg periodic acid. Exhibit A, p. 3. The removal rates obtained using Composition A were 288, 375, and 400 angstroms/minute at various polishing conditions of down force and table speed. *Id.* at 4-5.

Exhibit A also describes the use of a polishing slurry having 2 wt% alumina abrasive and 0.1 mols/kg of periodic acid (Composition Q) to polish platinum (Pt), which is also a noble metal. *Id.* at 37-39. The platinum removal rates obtained were between 1598 angstroms/minute. *Id.* at 38.

These portions of Exhibit A clearly describe compositions and tests that were actually performed using such compositions and, thereby evidence actual reduction to practice of the invention as recited in independent claim 77. Both of the tests described above involved polishing a substrate having a noble metal with a composition having an abrasive and periodic acid. The periodic acid concentration used was within the claimed range of periodic acid, and the removal rates obtained were also within the claimed range of removal rates.

9. Independent claim 94 as currently pending reads as follows:

94. A combination of a chemical mechanical polishing composition in contact with a substrate surface having at least one feature thereon comprising a noble metal, comprising:

a substrate having a surface, wherein said surface comprises a dielectric material and has at least one feature thereon comprising a noble metal, and wherein said surface is contacting a composition comprising:

periodic acid in an amount from about 0.05 to about 0.3 moles/kilogram; and an abrasive in an amount from about 0.2 to about 6 weight percent, said composition having a pH from above pH 5 to about pH 10;

and wherein on polishing the substrate surface with the composition contacting the surface the selectivity of the composition for polishing the noble metal-containing material over polishing the dielectric material is at least 1:1.

Exhibit A describes the results of several tests made with various polishing compositions (Compositions F, G, H, I, J, and K) for polishing a substrate comprising iridium, a noble metal, and TEOS (tetraethyl orthosilicate), a dielectric. *Id.* at 15-24. Each of these compositions utilized 2.3 grams of periodic acid, which converts to approximately 0.1 mols/kg. *Id.* (As a titrant was used in each of these compositions to adjust the pH, the exact concentration of periodic acid would depend upon the amount of titrant used. The amount of titrant used, however, was not significant enough to radically change the concentration of the periodic acid, which, accordingly, would still be within the claimed ranged of about 0.05 to about 0.3 mols/kg.) Further, the concentration of the abrasive in each of the compositions was approximately 2-2.5g (noting that two abrasives were used and that the CR-30 abrasive contained 16 weight percent alumina). This converts to approximately 2-2.5 weight percent, again, depending upon the amount of titrant used but would still be within the claimed range of about 0.2 to about 6 weight percent. (Exhibit A also describes a composition having 6 weight percent abrasive (Composition P), which would be easily understood as an abrasive concentration that could be used in a polishing composition. *Id.* at 35.) The pH of each of these compositions ranges from 6.7-7.3, and the TEOS selectivity ratio also ranges from 1:1.3 to 3.9:1.

The above referenced portions of Exhibit A clearly describe compositions and tests that were actually performed using such compositions and, thereby evidence actual reduction to practice of the invention as recited in independent claim 94. All of these tests involved polishing a substrate comprising a noble metal substrate and a dielectric with a composition having an abrasive and periodic acid as recited in claim 94. The periodic acid and abrasive concentrations and the pH for these compositions were within the claimed ranges, and the resulting selectivity ratios clearly illustrate a ratio of at least 1:1 as recited in the claim.

10. For example, independent claim 112 currently pending reads as follows:

> 112. A combination of a composition in contact with a substrate surface having at least one feature thereon comprising a noble metal, comprising:
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> A) a composition consisting essentially of:
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> 1) water;
>
> 2) periodic acid in an amount from about 0.05 to about 0.3 moles/kilogram;
>
> 3) an alumina abrasive in an amount from about 0.2 to about 6 weight percent;
>
> 4) optionally, a pH-adjusting agent in an amount sufficient to cause the pH of the slurry to be between about 1 to about 4 or between about 5 to about 10;
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> 5) optionally, a suspension agent;
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> wherein said composition is contacting
>
> B) a substrate surface having at least one feature thereon comprising a noble metal.

Exhibit A describes several compositions and test results that evidence reduction to practice of the invention as claimed in claim 112. First, each element recited in claim 112 was reduced to practice in the compositions and tests described above in connection with claim 94, and further including Composition E, *Id.* at 13-15, noting that (i) each composition contained water, (ii) the abrasive was alumina, (iii) ammonium hydroxide was used to adjust the pH of these compositions to 6.7-7.3, and (iv) each composition contained a suspension agent comprising various compositions (*e.g.*, Alumina-C, Darvan C, Ludox TM50, ethyl carbonate, succinic acid, and CR140), *Id.* at 13-24 (in particular noting the description regarding Composition E and the use of the second abrasive for better suspension).

In addition, Composition B comprised, 2 weight percent alumina abrasive and 0.1 mol/kg periodic acid, and the pH was adjusted with tetramethyl ammonium hydroxide to a between 6 and 7. *Id.* at 7. This composition was used to polish iridium, a noble metal. *Id.* at 7. Further, Composition D describes using a polishing slurry composition to polish iridium. *Id.* at 10-12. This composition comprises 2 weight percent alumina abrasive and 0.1 mols/kg periodic acid. *Id.* at 12. The pH of this slurry is adjusted with ammonium hydroxide to a pH of about 3-4. *Id.*

Further, Composition N describes a platinum (noble metal) polishing composition comprising 2 weight percent alumina abrasive and 0.1 moles/kg of periodic acid at a pH of 1.6. *Id.* at 31.

These portions of Exhibit A clearly describe various compositions and test that were actually performed using such compositions and, thereby evidence actual reduction to practice of the invention as recited in independent claim 112. These tests involved polishing a substrate having a noble metal with a composition having an alumina abrasive and periodic acid as recited in claim 112. The abrasive and periodic acid concentrations were within the ranges recited in claim 112. The pH of the various slurry compositions were either between about 1 to about 4 or between about 5 to about 10 as recited in claim 112. Further, these compositions utilized various suspension agents as recited in claim 112.

11. We declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated: 6/27/2007

Robert J. Small

Dated: _____

Zheifei J Chen

Compositions for Nobel Metal Chemical-Mechanical Planarization Processes

FIELD OF THE INVENTION

The present invention relates generally to compositions for Nobel Metal chemical mechanical planarization or polishing processes and, in particular, to compositions for chemical mechanical planarization or polishing processes of Nobel Metals such as Ir and Pt and their oxides.

BACKGROUND OF THE INVENTION

Chemical mechanical planarization (CMP) or polishing processes are well established for modern semiconductor interconnect technology employing metals such as W, Cu and Al. In stark contrast, only very little is known so far about CMP processes of noble metals or noble metal alloys, for example, Au, Ag and the group VIII metals of the periodic table such as Pt and Ir, and their oxides. However, interest in these metals is gaining momentum since they are used as electrodes and barrier materials in Gigabit DRAMs and FeRAMs.

Semiconductor companies, world-wide, are making efforts to commercialize high dielectric constant and ferroelectric thin films in, for example, advanced DRAMs and ferroelectric random access memories (FeRAMs), respectively. These materials include $BaSrTiO_3$ (BST) for forming capacitors dielectrics (DRAM storage capacitors or coupling capacitors in general circuits) in submicron integrated circuits because of their high dielectric constant. Additionally, materials such as $PbZrTiO_3$ (PZT) and $SrBi_2Ti_2O_9$ (SBT) that can store charge permanently are employed in the formation of non-volatile FeRAM memory. The

chemical properties of $BaSrTiO_3$, $PbZrTiO_3$, and $SrBi_2Ti_2O_9$ require that they be used with noble metals or noble metal alloys such as Pt, Ir, IrO_2, et cetera.

However, conventional patterning of these materials by dry etching processes has faced considerable difficulties such as taper angle, fence formation, and residual particles leading to contamination. Some fundamental difficulties of conventional dry etching processes are due to the predominantly physical (not chemical) mechanism for material removal thereby resulting in formation of unwanted structures at the edges of the electrodes.

For the forgoing reasons, there is a need for new, novel and useful chemical compositions for chemical mechanical planarization or polishing processes of Nobel Metal or group VIII metals of the periodic table such as Pt and Ir and their oxides, for example, IrO_2. Furthermore, there is a need for new, novel and useful chemical compositions for planarization or polishing of Nobel Metals that are compatible with standard chemical mechanical planarization or polishing equipment. Furthermore, there is a need for CMP slurry compositions that polish Nobel Metals at desired high polishing rates while minimizing surface imperfections, defects, corrosion, recessing and erosion.

Description

Ir Polishing Compositions

Composition A

One preferred Ir polishing composition pursuant to the present invention ("Composition A") is comprised of an alpha-alumina abrasive, Periodic Acid (H_5IO_6), and de-ionized ("DI") water. One example of component concentrations for Composition A is shown in the following table.

Composition A Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1mol/kg
DI Water	Remaining weight amount to obtain final desired amount of Composition A

Thus, for example, 10 kilograms of Composition A requires 200 grams of alpha-alumina abrasive plus 1 mole of Periodic Acid and the remaining amount DI water.

pH Ranges

Composition A may have a general pH range of 1, 2 to about 2.5 and a preferred pH of about 1.5.

Preparation

Generally, Composition A is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added and then the Periodic Acid (H_5IO_6) is added.

Composition A is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH and removal rate for Composition A.

Mixing Ratio, Process, pH and Removal Rate

Mixing Ratio	Process	pH	Ir Removal Rate (A/min)
2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Periodic Acid DI water	4/0/50/51/150	1.5 – 2.5	288

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed of 51 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as the polishing pad on the primary platen of the polisher and a Polytex pad was used as the buff pad on the secondary platen of the polisher. Composition A was stirred thoroughly before and during its use.

Composition A, when employed according to the above process, provided an Ir removal rate of approximately 288 angstroms per minute.

Additionally, Composition A achieved an Ir removal rate of approximately 375 angstroms per minute when carried out according to the above process with the exception of increasing the down force pressure from 4 psi to a down force pressure of 6 psi. Furthermore, Composition A achieved an Ir removal rate of approximately 400 angstroms per minute when carried out according to the above process with the exception of increasing the table speed from 50 rpm to 70 rpm.

Ir Polishing Compositions Including Titration with TMAH

Composition B

Another preferred Ir polishing composition pursuant to the present invention ("Composition B") is comprised of an alpha-alumina abrasive, Periodic Acid (H_5IO_6), de-ionized ("DI") water, and a base in the form of Tetramethylammonium Hydroxide (TMAH). One example of component concentrations for Composition B is shown in the following table.

Composition B Component Concentration

Component	**Component Concentration**
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1mol/kg
DI Water	Remaining weight amount to obtain final desired amount of

	Composition B
Tetramethylammonium Hydroxide (TMAH)	Titrate with TMAH to a pH of approximately between 6 and 7

For example, 10 kilograms of Composition B requires 200 grams of alpha-alumina abrasive plus 1 mole of Periodic Acid and the remaining amount DI water. This chemistry is then titrated with TMAH to obtain a final pH of about 6 to about 7.

pH Ranges

Composition B may have a general pH range of about 6 to about 7 and a preferred pH of about 7.

Preparation

Generally, Composition B is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with TMAH to obtain a final pH value of about 6 to about 7. Composition B is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH and removal rate for Composition B.

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Mixing Ratio, Process, pH and Removal Rate

Mixing Ratio	Process	pH	Ir Removal Rate (A/min)
2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Periodic Acid DI water Titrate with TMAH to a pH of approximately 7	4/0/50/51/150	6-7	325

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed 51 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as the polishing pad on the primary platen, and a Polytex pad was used as the buff pad on the secondary platen. Composition B was stirred thoroughly before and during its use.

Composition B, when employed according to the above process, provided an Ir removal rate of approximately 325 angstroms per minute.

Ir Polishing Compositions Including Titration with NH_4OH

Composition C

Another preferred Ir polishing composition pursuant to the present invention ("Composition C") is comprised of an alpha-alumina abrasive, Periodic Acid (H_5IO_6), de-ionized ("DI") water, and a base in the form of Ammonium Hydroxide (NH_4OH). One example of component concentrations for Composition C is shown in the following table.

Composition C Component Concentration

Component	**Component Concentration**
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition C
Ammonium Hydroxide (NH_4OH)	Titrate with NH_4OH to a pH of approximately 7

For example, 10 kilograms of Composition C requires 200 grams of alpha-alumina abrasive plus 1 mole of Periodic Acid and the remaining amount DI water. This chemistry is then titrated with NH_4OH to obtain a final pH of about 6 to about 7.

pH Ranges

Composition C may have a general pH range of about 6 to about 7 and a preferred pH range of about 7.

Preparation

Generally, Composition C is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to obtain a final pH value of about 7. Composition C is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rate and selectivity for Composition C.

Mixing Ratio, Process, pH, Removal Rate, and Selectivity

Mixing Ratio	**Process**	**pH**	**Ir Removal Rate (A/min)**	**Ir:TEOS Selectivity**
2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Periodic Acid Remaining % DI water Titrate with NH_4OH to a pH of approximately 7	5/0/90/50/150	6 - 7	360	1.8:1

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 5 psi, a back pressure of 0 psi, a table speed of 90 rpm, a carrier speed 50 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as the polishing pad on the primary platen, and a Polytex pad was used as the buff pad on the secondary platen. Composition C was stirred thoroughly before and during its use.

Composition C, when employed according to the above process, provided an Ir removal rate of approximately 360 angstroms per minute and an Ir:TEOS selectivity of 1.8:1.

Composition D

Another preferred Ir composition pursuant to the present invention ("Composition D") is comprised of an alpha-alumina abrasive, Periodic Acid (H_5IO_6), de-ionized ("DI") water, and a base in the form of Ammonium Hydroxide (NH_4OH). One example of component concentrations for Composition D is shown in the following table.

Composition D Component Concentration

Component	**Component Concentration**
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition D

Ammonium Hydroxide (NH_4OH)	Titrate with NH_4OH to a pH of approximately 3

For example, 10 kilograms of Composition D requires 200 grams of alpha-alumina abrasive plus 1 mole of Periodic Acid and the remaining amount DI water. This chemistry is then titrated with NH_4OH to obtain a final pH of about 3.

pH Ranges

Composition D may have a general pH range of about 2 to about 4 and a preferred pH range of about 3.

Preparation

Generally, Composition D is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to obtain a final pH value of about 3. Composition D is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rate and selectivity for Composition D.

Mixing Ratio, Process, pH, Removal Rate and Selectivity

Mixing Ratio	Process	pH	Ir Removal Rate (A/min)	(Ir:TEOS) Selectivity
2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Periodic Acid Remaining % DI water Titrate with NH_4OH to a pH of approximately 3	5/0/90/50/150	3 - 4	320	1:1.5

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 5 psi, a back pressure of 0 psi, a table speed of 90 rpm, a carrier speed 50 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as the polishing pad on the primary platen, and a Polytex pad was used as the buff pad on the secondary platen. Composition D was stirred thoroughly before and during its use.

Composition D, when employed according to the above process, provided an Ir removal rate of approximately 320 angstroms per minute and an Ir:TEOS selectivity of 1:1.5.

Ir Polishing Compositions having Suspension Agents

Composition E

Another preferred Ir polishing composition pursuant to the present invention ("Composition E") adds a second abrasive to Composition D for making a better suspension. In one preferred form, the second abrasive is Alumina-C as a 15% suspension. One example of component concentrations for Composition E is shown in the following table.

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Composition E Component Concentration

Component	**Component Concentration**
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition E
Ammonium Hydroxide (NH_4OH)	Titrate with NH_4OH to a pH of approximately 3

Alumina-C (15% suspension)	0.9 wt%

pH Ranges

Composition E may have a general pH range of about 2 to about 4 and a preferred pH range of about 3.

Preparation

Generally, Composition E is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to obtain a final pH value of about 3. Finally, the second abrasive, Alumina-C as a 15% suspension, is added. Continuous stirring is maintained during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rate and selectivity for Composition E.

Mixing Ratio, Process, pH, Removal Rate, and Selectivity

Mixing Ratio	**Process**	**pH**	**Ir Removal Rate (A/min)**	**(Ir:TEOS) Selectivity**

2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Periodic Acid Remaining % DI water Titrate with NH_4OH to a pH of approximately 3 0.9wt% Second Abrasive (e.g., Alumina-C)	5/0/90/50/150	3 - 4	260	1:2.2

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 5 psi, a back pressure of 0 psi, a table speed of 90 rpm, a carrier speed of 50 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as polishing pad on the primary platen, and a Polytex pad was used as the buff pad on the secondary platen. Composition E was stirred thoroughly before and during its use.

Composition E, when employed according to the above process, provided an Ir removal rate of approximately 260 angstroms per minute and an Ir:TEOS selectivity of 1:2.2.

Composition F

Another preferred Ir polishing composition pursuant to the present invention ("Composition F") adds a second abrasive to Composition C for making a better suspension. In one preferred form, a slurry suspension agent, Laponite (a product of Southwestern Clay Co.)

was used. One example of component concentrations for Composition F is shown in the following table.

Composition F Component Concentration

Component	Component Concentration
Periodic Acid	2.3 grams
DI Water	76 grams
Ammonium Hydroxide (NH_4OH)	Titrate the above components with NH_4OH to a pH of approximately 7
DI Water	8 grams
Laponite (Second Abrasive)	0.5 grams
Alpha-Alumina Abrasive (CR30 @ 16wt%)	12.5 grams

Preparation

In one form, Composition F is prepared by preparing a container of DI water (76 grams) to which the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to a final pH value of about 7 thereby defining an oxidizer (Oxidizer "A"). Next, the Laponite and the alpha-alumina are added to eight grams of DI water thereby defining an abrasive (Abrasive "A"). Oxidizer A is then added to Abrasive A for completing the preparation of Composition F. Continuous stirring is maintained during at least the composition preparation.

Composition G

Another preferred Ir polishing composition pursuant to the present invention ("Composition G") adds a slurry suspension agent in the form of Darvan C to Composition C for making a better suspension. One example of component concentrations for Composition G is shown in the following table.

Composition G Component Concentration

Component	**Component Concentration**
Periodic Acid	2.3 grams
DI Water	76 grams
Ammonium Hydroxide (NH_4OH)	Titrate the above components with NH_4OH to a pH of approximately 7
DI Water	8 grams
Darvan C (Second Abrasive)	0.5 grams
Alpha-Alumina Abrasive (CR30 @ 16wt%) (First Abrasive)	12.5 grams

Preparation

In one form, Composition G is prepared by preparing a container of DI water (76 grams) to which the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to a final pH value of about 7 thereby defining an oxidizer (Oxidizer "A"). Next, the Darvan C and the alpha-alumina are added to eight grams of DI water thereby defining an abrasive (Abrasive

"B"). Oxidizer A is then added to Abrasive B for completing the preparation of Composition G. Continuous stirring is maintained during the composition preparation.

Composition H

Another preferred Ir polishing composition pursuant to the present invention ("Composition H") adds a second abrasive to Composition C for making a better suspension. In another preferred form, the second abrasive is Ludox TM50 (Dupont, Inc. colloidal silica). One example of component concentrations for Composition H is shown in the following table.

Composition H Component Concentration

Component	**Component Concentration**
Periodic Acid	2.3 grams
DI Water	76 grams
Ammonium Hydroxide (NH_4OH)	Titrate the above components with NH_4OH to a pH of approximately 7
DI Water	8 grams
Ludox TM50 (Second Abrasive)	0.5 grams
Alpha-Alumina Abrasive (CR30 @ 16wt%) (First Abrasive)	12.5 grams

Preparation

In one form, Composition H is prepared by preparing a container of DI water (76 grams) to which the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to a

final pH value of about 7 thereby defining an oxidizer (Oxidizer "A"). Next, the Ludox TM50 (the second abrasive) and the alpha-alumina (the first abrasive) are added to eight grams of DI water thereby defining an abrasive (Abrasive "C"). Oxidizer A is then added to Abrasive C for completing the preparation of Composition H. Continuous stirring is maintained during at least the composition preparation.

Composition I

Another preferred Ir polishing composition pursuant to the present invention ("Composition I") adds a slurry suspension agent to Composition C for making a better suspension. In another preferred form, the agent chemical is Ethyl Carbonate. One example of component concentrations for Composition I is shown in the following table.

Composition I Component Concentration

Component	**Component Concentration**
Periodic Acid	2.3 grams
DI Water	76 grams
Ammonium Hydroxide (NH_4OH)	Titrate the above components with NH_4OH to a pH of approximately 7
DI Water	8 grams
Ethyl Carbonate	0.5 grams
Alpha-Alumina Abrasive (CR30 @ 16wt%) (First Abrasive)	12.5 grams

Preparation

In one form, Composition I is prepared by preparing a container of DI water (76 grams) to which the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to a final pH value of about 7 thereby defining an oxidizer (Oxidizer "A"). Next, the Ethyl Carbonate and the alpha-alumina are added to eight grams of DI water thereby defining an abrasive (Abrasive "D"). Oxidizer A is then added to Abrasive D for completing the preparation of Composition I. Continuous stirring is maintained during the composition preparation.

Composition J

Another preferred Ir polishing composition pursuant to the present invention ("Composition J") adds an organic acid to Composition C for making a better suspension. In another preferred form, the organic acid is Succinic acid. One example of component concentrations for Composition J is shown in the following table.

Composition J Component Concentration

Component	**Component Concentration**
Periodic Acid	2.3 grams
DI Water	76 grams
Ammonium Hydroxide (NH_4OH)	Titrate the above components with NH_4OH to a pH of approximately 7
DI Water	7.5 grams
Succinic acid	1.0 grams
Alpha-Alumina Abrasive (CR30 @	12.5 grams

16wt%)	

Preparation

In one form, Composition J is prepared by preparing a container of DI water (76 grams) to which the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to a final pH value of about 7 thereby defining an oxidizer (Oxidizer "A"). Next, the Succinic acid (the organic acid) and the alpha-alumina are added to 7.5 grams of DI water thereby defining an abrasive (Abrasive "E"). Oxidizer A is then added to Abrasive E for completing the preparation of Composition J. Continuous stirring is maintained during the composition preparation.

Composition K

Another preferred Ir polishing composition pursuant to the present invention ("Composition K") adds a second abrasive to Composition C for making a better suspension. In another preferred form, the second abrasive is an Alpha-Alumina Abrasive in the form of CR140. One example of component concentrations for Composition K is shown in the following table.

Composition K Component Concentration

Component	**Component Concentration**
Periodic Acid	2.3 grams
DI Water	76 grams
Ammonium Hydroxide (NH_4OH)	Titrate the above components with NH_4OH to a pH of approximately 7
DI Water	3.5 grams

CR140 @ 20 wt% (Second Abrasive)	5.0 grams
Alpha-Alumina Abrasive (CR30 @ 16 wt%) (First Abrasive)	12.5 grams

Preparation

In one form, Composition K is prepared by preparing a container of DI water (76 grams) to which the Periodic Acid (H_5IO_6) is added. This chemistry is then titrated with NH_4OH to a final pH value of about 7 thereby defining an oxidizer (Oxidizer "A"). Next, CR140 (the second abrasive) and CR30 (the first abrasive) are added to 3.5 grams of DI water thereby defining an abrasive (Abrasive "F"). Oxidizer A is then added to Abrasive F for completing the preparation of Composition K. Continuous stirring is maintained during the composition preparation.

The following table summarizes preparation conditions for Compositions F through K.

Compositions F Through K Component Concentration

Composition	DI Water	Second Abrasive	First Abrasive	Stir	Add Oxidizer	Stir
Composition F	8 grams	0.5 grams Laponite	12.5 grams	2 hours	79 grams of Oxidizer "A"	> 20 min.
Composition G	8 grams	0.5 grams Darvan C	12.5 grams	2 hours	79 grams of Oxidizer "A"	> 20 min.
Composition H	8 grams	0.5 grams Ludox TM50	12.5 grams	2 hours	79 grams of Oxidizer "A"	> 20 min.
Composition I	8 grams	0.5 grams Ethyl Carbonate	12.5 grams	2 hours	79 grams of Oxidizer "A"	> 20 min.

Composition J	7.5 grams	1.0 grams Succinic acid	12.5 grams	2 hours	79 grams of Oxidizer "A"	> 20 min.
Composition K	3.5 grams	5 grams CR140 (20% wt)	12.5 grams	2 hours	79 grams of Oxidizer "A"	> 20 min.

The following table sets forth the pH, settle down time, Ir removal rate and Ir:TEOS selectivity for Compositions F through K.

pH, Settle Down Time, Ir Removal Rate and Selectivity for Compositions F Through K

Composition	**pH**	**Settle Down (ml/min or ml/hrs)**	**Ir Removal Rate (A/min)**	**(Ir:TEOS) Selectivity**
Composition F	7.3	9ml/10 min	240	2.7:1
Composition G	7.3	9ml/10 min	340	2.1:1
Composition H	7.3	9ml/10 min	240	3.9:1
Composition I	7.3	9ml/10 min	350	2.3:1
Composition J	6.7	5ml/2 hrs	80	1:1.3
Composition K	6.9	10ml/10 min	230	3.4:1

The above CMP processes for Compositions F through K were carried out on an IPEC 576 polisher using a Thomas West XY pad and each was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table or platen speed of 200 rpm, a carrier speed of

18 rpm, and a composition flow rate of 150 ml/min. Compositions F through K were stirred thoroughly before and during their use.

IrO_2 Polishing Compositions

Composition L (IrO_2)

One preferred Iridium Oxide (IrO_2) polishing composition pursuant to the present invention ("Composition L") is comprised of an alpha-alumina abrasive, Hydrazine hydrate (NH_2-$NH_2 \cdot H_2O$), and de-ionized ("DI") water. One example of component concentrations for Composition L is shown in the following table.

Composition L Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Hydrazine	0.1 mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition L

pH Ranges

Composition L may have a general pH range of about 8 to about 10 and a preferred pH range of about 9.0 to about 9.5.

Preparation

Generally, Composition L is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Then, Hydrazine hydrate is added. Composition L

is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

Mixing Ratio, Process, pH and Removal Rate

Mixing Ratio	Process	pH	IrO_2 Removal Rate (A/min)
2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Hydrazine hydrate DI water	4/0/50/51/150	9.0-9.5	880

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed 51 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 ove ar Suba IV was used as the polishing pad on the primary platen of the polisher and a Polytex pad was used as buff pad on the secondary platen of the polisher. Composition L was stirred thoroughly before and during its use.

Composition L, when employed according to the above process, provided an IrO_2 removal rate of approximately 880 angstroms per minute.

Another example of component concentrations for Composition L is shown in the following table.

Composition L Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Hydrazine hydrate	0.05 mol/kg
DI Water	Remaining weight amount to obtain final desired amount of Composition L

pH Ranges

The above example has a preferred pH range of about 9.0.

CMP Process:

The following table shows one example of the mixing ratio, process, pH and removal rate for Composition L having a Hydrazine hydrate component concentration of 0.05 mol/kg.

Mixing Ratio, Process, pH and Removal Rate

Mixing Ratio	Process	pH	IrO_2 Removal Rate (A/min)
2 wt% Alpha-Alumina Abrasive 0.05 mol/1kg Hydrazine hydrate DI water	4/0/50/51/150	9.0	740

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed of 51 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as the polishing pad on the primary platen of the polisher and a Polytex pad was used as buff pad on the secondary platen of the polisher. The above Composition was stirred thoroughly before and during its use.

Composition L, when employed according to the above process and having a 0.05 mol/kg hydrazine component concentration, provided an IrO_2 removal rate of approximately 740 angstroms per minute.

Composition M (IrO_2)

Another preferred Iridium Oxide (IrO_2) polishing composition pursuant to the present invention ("Composition M") is comprised of an alpha-alumina abrasive, Tetramethylammonium Hydroxide (TMAH), and de-ionized ("DI") water. One example of component concentrations for Composition M is shown in the following table.

Composition M Component Concentration

Component	**Component Concentration**
Alpha-Alumina Abrasive (CR30)	2 wt%
Tetramethylammonium Hydroxide	0.1mol/1kg
DI Water	Remaining weight amount to

	obtain final desired amount of Composition M

pH Ranges

Composition M may have a general pH range of about 9 to about 11 and a preferred pH of about 10.

Preparation

Generally, Composition M is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Then, the Tetramethylammonium Hydroxide (TMAH) is added. Composition M is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

Mixing Ratio, Process, pH and Removal Rate

Mixing Ratio	**Process**	**pH**	**IrO_2 Removal Rate (A/min)**
2 wt% Alpha-Alumina Abrasive 0.1mol/kg Tetramethylammonium Hydroxide DI water	4/0/50/51/150	10	635

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed of 51 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-

1000 over a Suba IV was used as the polishing pad on the primary platen of the polisher and a Polytex pad was used as buff pad on the secondary platen of the polisher. The above Composition was stirred thoroughly before and during its use.

Composition M, when employed according to the above process, provided an IrO_2 removal rate of approximately 635 angstroms per minute.

Another example of component concentrations for Composition M is shown in the following table.

Composition M Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Tetramethylammonium Hydroxide	0.03 mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition M

pH Ranges

Composition M having a Tetramethylammonium Hydroxide component concentration of 0.03 mol/kg has a preferred pH range of about 9 to about 10.

CMP Process:

The following table shows one example of the mixing ratio, process, pH and removal rate for Composition M having a Tetramethylammonium Hydroxide component concentration of 0.03 mol/kg.

Mixing Ratio, Process and Removal Rate

Mixing Ratio	Process	pH	IrO2 Removal Rate (A/min)
2 wt% Alpha-Alumina Abrasive 0.03 mol/kg Tetramethylammonium Hydroxide DI water	4/0/50/51/150	9 - 10	320

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed of 51 rpm, and a composition flow rate of 150 ml/min. A stacked pad of IC-1000 over a Suba IV was used as the polishing pad on the primary platen of the polisher, and a Polytex pad was used as buff pad on the secondary platen of the polisher. The above Composition was stirred thoroughly before and during its use.

Composition M, when employed according to the above process and having a 0.03 mol/kg Tetramethylammonium Hydroxide component concentration, provided an IrO_2 removal rate of approximately 320 angstroms per minute.

Platinum (Pt) Polishing Compositions

Composition N

One preferred Platinum (Pt) polishing composition pursuant to the present invention ("Composition N") is comprised of an alpha-alumina abrasive, Periodic Acid (H_5IO_6), and de-ionized ("DI") water. Note that Composition N is comprised of the same components as Composition A delineated hereinabove. One example of component concentrations for Composition N is shown in the following table.

Composition N Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1 mol/kg
DI Water	Remaining weight amount to obtain final desired amount of Composition N

pH Ranges

Composition N has a preferred pH of about 1.6.

Preparation

Generally, Composition N is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Then, the Periodic Acid (H_5IO_6) is added.

Composition N is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rates and selectivity for Composition N.

Mixing Ratio, Process, pH, Removal Rates, and Selectivity

Mixing Ratio	Process	pH	Removal Rate (A/min) Pt	Removal Rate (A/min) BPSG	Pt: BPSG Selectivity
2 wt% Alpha-Alumina Abrasive 0.1mol/1kg Periodic Acid DI water	2/200/18/150	1.6	131	180	1:1.5

The above CMP process for Composition N was carried out on an IPEC 576 polisher using a Thomas West XY pad and was achieved by applying a down force pressure of 2 psi, a table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a composition flow rate of 150 ml/min. Composition N was stirred thoroughly before and during its use.

Composition N, when employed according to the above process, provides a Pt removal rate of 131 A/min and a Boron phosphorous spin on glass (BPSG) removal rate of 180 A/min thereby resulting in a Pt:BPSG selectivity of 1:1.5.

Composition O

Another preferred composition pursuant to the present invention ("Composition O") comprises an alpha-alumina abrasive, Periodic Acid (H_5IO_6), Ammonium Chloride (NH_4Cl), and de-ionized ("DI") water. One example of component concentrations for Composition O is shown in the following table.

Composition O Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Periodic Acid	0.1mol/1kg
Ammonium Chloride	0.1 mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition O

pH Ranges

The present composition may have a general pH range of about 1.2 to about 1.8 and a preferred range of about 1.6.

Preparation

Generally, Composition O is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Periodic Acid (H_5IO_6) is added. Then the Ammonium Chloride is added. Composition O is preferably continuously stirred within the container during the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rates and selectivity for Composition O.

Mixing Ratio, Process, pH, Removal Rates and Selectivity

Mixing Ratio	Process	pH	Pt Removal Rate (A/min)	Removal Rate (A/min) BPSG	Pt: BPSG Selectivity
2 wt% Alpha-Alumina Abrasive 0.1mol/kg Periodic Acid 0.1 mol/kg Ammonium Chloride DI water	2/200/18/150	1.6	443	56	8:1

The above CMP process for Composition O was carried out on an *IPEC 576* polisher using a Thomas West XY pad and was achieved by applying a down force pressure of 2 psi, a

table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a composition flow rate of 150 ml/min. Composition O was stirred thoroughly before and during its use.

Composition O, when employed according to the above process, provides a Pt removal rate of 443 A/min and a BPSG removal rate of 56 A/min thereby resulting in a Pt:BPSG selectivity of 8:1.

Composition P

Another preferred composition pursuant to the present invention ("Composition P") comprises an alpha-alumina abrasive, Periodic Acid (H_5IO_6), Ammonium Chloride (NH_4Cl), and de-ionized ("DI") water. One example of component concentrations for Composition P is shown in the following table.

Composition P Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	6 wt%
Periodic Acid	0.1 wt%
Ammonium Chloride	0.1 wt%
DI Water	Remaining weight amount to obtain final desired amount of Composition P

pH Ranges

The present composition has a preferred pH range of about 1.5 to about 2.0.

Preparation

Generally, Composition P is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Periodic Acid (H_5IO_6) is added. Then, the Ammonium Chloride (NH_4CI) is added. Composition P is preferably continuously stirred within the container during at least the composition preparation.

CMP Processes:

The following table shows several examples of the processes and removal rates for Composition P.

Processes and Removal Rates

Process	Pt Removal Rate (A/min)
2/200/18/70	220
4/200/18/70	470
6/200/18/70	750
7/200/18/70	1,020

The above CMP processes for Composition P were carried out on an IPEC 576 polisher using a Thomas West XY pad and were achieved by applying a down force pressure of 2 psi, 4 psi, 6 psi and 7 psi, respectively. All processes were achieved by applying a table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a composition flow rate of 70 ml/min. Composition P was stirred thoroughly before and during its use.

Composition P, when employed according to the above processes, provides Pt removal rates of 220 A/min, 470 A/min, 750 A/min, and 1,020 A/min, respectively.

Composition Q

Another preferred composition pursuant to the present invention ("Composition Q") is comprised of an alpha-alumina abrasive, Ammonium Chloride (NH_4Cl), and de-ionized ("DI") water.

Composition Q Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Ammonium Chloride	0.1 mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition Q

pH Ranges

The present composition may have a general pH range of about 5.0 to about 6.0 and a preferred pH of about 5.4.

Preparation

Generally, Composition Q is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Ammonium Chloride is added.

Composition Q is preferably continuously stirred within the container during the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rates and selectivity for Composition Q.

Mixing Ratio, Process, pH, Removal Rates and Selectivity

Mixing Ratio	Process	pH	Pt Removal Rate (A/min)	Removal Rate (A/min) BPSG	Pt: BPSG Selectivity
2 wt% Alpha-Alumina Abrasive 0.1 mol/kg Ammonium Chloride DI water	2/0/200/18/150	5.4	1598	145	11:1

The above CMP process for Composition Q was carried out on an IPEC 576 polisher using a Thomas West XY pad and was achieved by applying a down force pressure of 2 psi, a back pressure of 0 psi, a table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a composition flow rate of 150 ml/min. Composition Q is preferably stirred thoroughly before and during its use.

Composition Q, when employed according to the above process, provides a Pt removal rate of 1,598 A/min and a BPSG removal rate of 145 A/min thereby resulting in a Pt:BPSG selectivity of approximately 11:1.

Composition R

Another preferred Pt polishing composition ("Composition R") pursuant to the present invention is comprised of an alpha-alumina abrasive, Hydrochloric acid (HCl) and de-ionized ("DI") water. One example of component concentrations for Composition R is shown in the following table.

Composition R Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Hydrochloric Acid	0.1 mol/kg
DI Water	Remaining weight amount to obtain final desired amount of Composition R

pH Ranges

The present composition may have a general pH range of about 1.0 to about 2.0 and a preferred pH of about 1.2.

Preparation

Generally, Composition R is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Then, the Hydrochloric Acid is added. Composition R is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rates and selectivity for Composition R.

Mixing Ratio, Process, pH, Removal Rates and Selectivity

Mixing Ratio	Process	pH	Pt Removal Rate (A/min)	BPSG Removal Rate (A/min)	Pt: BPSG Selectivity
2 wt% Alpha-Alumina Abrasive 0.1 mol/kg Hydrochloric Acid DI water	2/0/200/18	1.2	334	26	13:1

CMP Processes:

The above CMP process for Composition R was carried out on an IPEC 576 polisher using a Thomas West XY pad and was achieved by applying a down force pressure of 2 psi, a

back pressure of 0 psi, a table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a composition flow rate of 150 ml/min. Composition R was stirred thoroughly before and during its use.

Composition R, when employed according to the above process, provides a Pt removal rate of 334 A/min, a BPSG removal rate of 26 A/min thereby resulting in a Pt:BPSG selectivity of 13:1.

Composition S

Another preferred Pt composition pursuant to the present invention ("Composition S") comprises an alpha-alumina abrasive, Hydrochloric acid (HCl), Ammonium Chloride (NH_4Cl), and de-ionized ("DI") water. One example of component concentrations for Composition S is shown in the following table.

Composition S Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Hydrochloric acid	0.1mol/1kg
Ammonium Chloride	0.1 mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition S

pH Ranges

Composition S may have a general pH range of about 1.0 to about 2.0 and a preferred pH of about 1.4.

Preparation

Generally, Composition S is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Next, the Hydrochloric acid is added. Then, the Ammonium Chloride (NH_4Cl) is added. Composition S is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH and removal rate for Composition S.

Mixing Ratio, Process and Removal Rate

Mixing Ratio	Process	pH	Pt Removal Rate (A/min)
2 wt% Alpha-Alumina Abrasive 0.1 mol/1kg Hydrochloric acid 0.1 mol/1kg Ammonium Chloride DI water	4/0/200/18/70	1.4	310

The above CMP process for Composition S was carried out on an IPEC 576 polisher using a Thomas West XY pad and was achieved by applying a down force pressure of 4 psi, a

back pressure of 0 psi, a table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a composition flow rate of 70 ml/min. Composition S was stirred thoroughly before and during its use.

Composition S, when employed according to the above process, provides a Pt removal rate of 310 A/min.

Composition T

Another preferred Platinum composition pursuant to the present invention ("Composition T") comprises an alpha-alumina abrasive, Hydroxylamine (HDA), and de-ionized ("DI") water.

Composition T Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
Hydroxylamine	0.1 mol/kg
DI Water	Remaining weight amount to obtain final desired amount of Composition T

pH Ranges

Composition T may have a general pH range of about 8 to about 9 and a preferred pH of about 8.5.

Preparation

Generally, Composition T is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Then, the Hydroxylamine is added. Composition T is preferably continuously stirred within the container during the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process, pH, removal rates and selectivity for Composition T.

Mixing Ratio, Process, pH, Removal Rates and Selectivity

Mixing Ratio	Process	pH	Removal Rate (A/min) Pt	Removal Rate (A/min) BPSG	Pt: BPSG Selectivity
2 wt% Alpha-Alumina Abrasive 0.1 mol/kg Hydroxylamine DI water	4/0/50/51/150	8.5	209	432	1:2

In the above example, the CMP process was carried out on IPEC 472 polisher and was achieved by applying a down force pressure of 4 psi, a back pressure of 0 psi, a table speed of 50 rpm, a carrier speed 51 rpm, and a composition flow rate of 150 ml/min. An IC-1000 k-grooved pad was used as the polishing pad on the primary platen of the polisher, and a Polytex pad was

used as buff pad on the secondary platen of the polisher. Composition T was stirred thoroughly before and during its use.

Composition T, when employed according to the above process, provides a Pt removal rate of 209 A/min and a BPSG removal rate of 432 A/min thereby resulting in a Pt:BPSG selectivity of 1:2.

Composition U (211)

Another preferred Platinum polishing composition pursuant to the present invention ("Composition U") is comprised of an alpha-alumina abrasive, Hydroxylamine hydrochloride ($NH_20H{\cdot}HCl$), and de-ionized ("DI") water. One example of component concentrations for Composition U is shown in the following table.

Composition U Component Concentration

Component	Component Concentration
Alpha-Alumina Abrasive (CR30)	2 wt%
$NH_20H{\cdot}HCl$	0.1 mol/1kg
DI Water	Remaining weight amount to obtain final desired amount of Composition U

pH Ranges

Composition U may have a general pH range of about 3.5 to about 4.5 and a preferred pH of about 4.0.

Preparation

Generally, Composition U is prepared by first preparing a container of DI water to which the alpha-alumina abrasive (CR30) is added. Then, the Hydroxylamine hydrochloride ($NH_20H{\cdot}HCl$) is added. Composition U is preferably continuously stirred within the container during at least the composition preparation.

CMP Process:

The following table shows one example of the mixing ratio, process and removal rate for Composition U.

Mixing Ratio, Process, pH, Removal Rates and Selectivity

Mixing Ratio	Process	pH	Pt Removal Rate (A/min)	Removal Rate (A/min) BPSG	Pt: BPSG Selectivity
2 wt% Alpha-Alumina Abrasive 0.1 mol/kg $NH_20H{\cdot}HCl$ DI water	2/0/200/18/150	4.0	393	70	5.6:1

The above CMP process for Composition U was carried out on an IPEC 576 polisher using a Thomas West XY pad and was achieved by applying a down force pressure of 2 psi, a back pressure of 0 psi, a table or platen speed of 200 rpm, a carrier speed of 18 rpm, and a

composition flow rate of 150 ml/min. Composition U is preferably stirred thoroughly before and during its use.

Composition U, when employed according to the above process, provides a Pt removal rate of 393A/min and a BPSG removal rate of 70 A/min thereby resulting in a Pt:BPSG selectivity of approximately 5.6:1.